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**1976 VIRUS TOLERANCE RATINGS  
FOR CORN STRAINS  
Grown in the Lower Corn Belt**

In cooperation with  
Missouri Agricultural Experiment Station and  
Ohio Agricultural Research and Development Center

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## Preface

To measure corn tolerance to natural virus infection by maize dwarf mosaic and maize chlorotic dwarf, breeders and researchers grew selected corn strains in test plots in lower parts of the Corn Belt. The results of these tests are given in this publication in two parts—corn strains grown in Missouri and those grown in Ohio.

Observers of the individual corn plants rated symptoms on a scale from 1 (no virus symptoms) to 9 (complete susceptibility). Infections varied in intensity between hybrids and inbreds. At all test locations, johnsongrass, an alternate host, was abundant near the plots. The rating variations within tests of inbreds and single cross and double cross hybrids are shown in tables in this publication.

## Virus Tolerance Ratings of Corn Strains Grown in Missouri<sup>1</sup>

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This study identifies corn strains evaluated in 1976 that exhibit tolerance to maize dwarf mosaic virus (MDMV) and maize chlorotic dwarf virus (MCDV). These results will be useful to growers for identifying hybrids with high levels of tolerance that are to be planted in areas of high virus incidence. Corn strains planted at two Missouri locations were rated for MDMV and MCDV symptoms under conditions of natural infection. Test plots were located on the Bonacker farm near House Springs, Jefferson County, and at the Delta Center experimental farm, Portageville, Pemiscot County.

Corn inbred lines, S<sub>1</sub> lines, single crosses, three-way and double crosses were hand planted in single-row plots consisting of 20 plants. Plants were spaced 1 foot apart. Each plot was replicated either two or three times, depending upon the experiment.

Planting at both locations was delayed until late May to encourage high levels of virus infection. Johnsongrass, an alternate host for the corn virus strains involved in these ratings, was abundant in and near the test plots at both locations.

### Virus Incidence

MDMV and MCDV were identified by plant symptoms at both locations. MDMV gives a typical mosaic pattern, whereas MCDV produces a vein clearing on infected leaves. Johnsongrass is the alternate host for both viruses. The corn

leaf aphid, *Aphis maidis*, and possibly other aphids are vectors for MDMV that can be transmitted mechanically. The leafhopper, *Graminella nigrifrons*, is the vector for MCDV that cannot be transmitted mechanically.

Each plant within a single-row plot was rated for virus symptoms on a 1 to 9 severity scale, with a rating of 9 as most severe. The ratings were made mainly for severity and not for specific types of virus. The plot mean was the average of the individual plant ratings. For each entry, replications were averaged to obtain the final rating.

MDMV was the predominate virus at both locations. The 1976 average virus ratings at House Springs for the tolerant single cross, Mo14W×Oh7B, were 4.0, slightly higher than for the previous years beginning 1972 (table 1). The susceptible single cross, Mo5×H55, was slightly lower, 6.8, than any previous year since 1968.

At the Delta Center, the average ratings were considerably higher for both crosses than in pre-

<sup>1</sup>Cooperative investigation between Agricultural Research Service, U.S. Department of Agriculture and the University of Missouri Agricultural Experiment Station, Columbia, Mo. Journal Series No. 7825.

<sup>2</sup>Research plant pathologist, research agronomist (Retired), both of Agricultural Research Service, U.S. Department of Agriculture; associate professor of entomology and research specialist, both of the University of Missouri-Columbia; and research technician, Agricultural Research Service, U.S. Department of Agriculture. All of Columbia, Mo.

Table 1.—Comparative virus ratings<sup>1</sup> for a susceptible and tolerant single cross to virus infections for 8 years at two locations in Missouri.

Single cross	1968	1969	1970	1971	1972	1973	1974	1975	1976	Average
Jefferson County:										
Mo5×H55	8.00	8.20	7.30	7.60	7.00	7.00	8.20	7.50	6.80	7.51
Mo14W×Oh7B	1.67	5.81	4.00	4.70	2.33	1.30	3.60	1.70	4.00	3.23
Pemiscot County:										
Mo5×H55	4.67	6.33	5.33	7.00	3.67	7.00	3.70	4.50	8.40	5.62
Mo14W×Oh7B	1.35	1.00	1.70	1.00	1.00	2.30	1.70	1.20	5.50	1.87

<sup>1</sup>Rating scale from 1 (no symptoms) to 9 (plant killed by virus).

**Table 2.—1976 virus ratings for commercial plus two check hybrids grown on the Delta Center near Portageville; Pemiscot County, Mo.; planted May 24 and rated August 9. Experiment V-8.**

Hybrids	Virus Ratings	DMRT <sup>1</sup>
Trojan X124	4.0	
Funk G26630	4.2	
Va35 x Oh514	4.4	
FFR FFR2283	4.7	
Trojan X142	4.5	
Pioneer 3145	4.6	
Funk G4776	4.6	
Trojan X3524	4.7	
Pioneer 3147	4.8	
ACCO AR38486	4.9	
DeKalb XL72B	5.0	
North-King FX723	5.2	
Columbiana XC8014	5.2	
DeKalb XL394	5.3	
Trojan MDM116	5.4	
P A G SX605	5.4	
Cargill EKP22356	5.4	
Ring Around RA2602W	5.4	
McNair X3137	5.5	
Oh7B x Mol4W <sup>2/</sup>	5.5	
Funk G27792	5.5	
P A G SX17A	5.5	
McCurdy 7474	5.5	
McNair X3121	5.6	
(Fr4C x Oh514)T232	5.6	
P A G X246014	5.7	
Funk G4525	5.7	
(Mol7 x Va35)Oh514	5.7	
Pioneer XA730	5.7	
McCurdy 9215	5.8	
Cargill 99W	5.9	
North-King FX79	6.0	
Columbiana H2660W	6.1	
P A G X246006	6.2	
McNair X233	6.3	
McCurdy 9498	6.4	
Ring Around RA36E	6.4	
ACCO UC6601	6.6	
Hulting X990	6.6	
Cargill EKP236034	6.6	
Columbiana H2550	6.7	
North-King FX95	6.7	
Columbiana H2740A	6.7	
Pioneer XA065	6.8	
McNair S338	6.8	
Hulting X980	6.8	
Farmland Co-op 2318	6.9	
Ring Around RA2601	7.0	
North-King FX715	7.1	
Acco UC8951	7.1	
Hulting 74174	7.1	
Coker 18	7.1	



**Table 2.—1976 virus ratings for commercial plus two check hybrids grown on the Delta Center near Portageville, Pemiscot County, Mo.; planted May 24 and rated August 9. Experiment V-8.—Continued.**

Hybrids	Virus Ratings	DMRT <sup>1</sup>
McCurdy MSX85	7.2	
NC+ 85	7.3	
NC+ 61	7.4	
FrMol7 x Oh514	7.6	
Farmland 2290	7.6	
ACCO AR41642	7.7	
Hulding X8800	7.7	
Ring Around RA2601	7.7	
NC+ 76	7.9	
Cargill 949	8.0	
NC+ 59	8.1	
H55 x Mo5 <sup>2/</sup>	8.4	
Coefficient of variation . . . . .		percent 13.0
Least significant different . . . . .		1.31

<sup>1</sup>Duncan's Multiple Range Test--Entries with the same line in common are not considered significantly different at the 5% level.

<sup>2</sup>Check hybrids.

**Table 3.—1976 virus ratings for commercial plus two check hybrids grown on the Bonacker farm near House Springs, Jefferson County, Mo.; planted May 21 rated August 4. Experiment V-7.**

Hybrids	Virus Ratings	DMRT <sup>1</sup>
Funk G4776	3.1	
Funk G26630	3.2	
Trojan X3524	3.2	
FFR FFR2283	3.4	
DeKalb XL72B	3.5	
Trojan X124	3.5	
Trojan X142	3.5	
McNair X3137	3.6	
McCurdy 9215	3.8	
McNair X233	3.9	
ACCO UC6601	4.0	
Columbiana XC8014	4.0	
Oh7B x Mol4W <sup>2/</sup>	4.0	
Ring Around RA36E	4.1	
Ring Around RA2602W	4.1	
North-King PX95	4.2	
Pioneer 3147	4.2	
Columbiana H2660W	4.2	
McCurdy 7474	4.2	
Funk G4525	4.2	
PAG X246006	4.3	
Coker 18	4.3	
Va35 x Oh514	4.3	

Table 3.—1976 virus ratings for commercial plus two check hybrids grown on the Bonacker farm near House Springs, Jefferson County, Mo.; planted May 21 rated August 4. Experiment V-7.—Continued.

Hybrids	Virus Ratings	DMRT <sup>1</sup>									
McCurdy 9498	4.3										
DeKalb XL394	4.3										
North-King PX723	4.4										
Pioneer XA065	4.4										
Pioneer XA730	4.4										
(FR4C x Oh514)T232	4.4										
(Mol7 x Va35)Oh514	4.4										
Trojan MDM116	4.5										
Cargill Exp22356	4.5										
Hulking 74174	4.6										
Pioneer 3145	4.6										
ACCO AR38486	4.6										
P A G X246014	4.7										
Cargill 99W	4.7										
P A G SX17A	4.7										
North-King PX79	4.7										
Funk G27792	4.7										
Farmland Co-op 2318	4.7										
P A G SX605	4.8										
Columbiana H2550	4.8										
Ring Around RA3602	4.9										
FRMol7 x Oh514	5.0										
ACCO AR41642	5.0										
Columbiana H2740A	5.1										
McCurdy MSX85	5.1										
NC+ 85	5.1										
Cargill Exp236034	5.2										
NC+ 61	5.2										
McNair X3121	5.3										
Hulking X990	5.4										
ACCO UC8951	5.4										
North-King PX715	5.5										
Cargill 949	5.5										
NC+ 76	5.6										
NC+ 59	5.7										
Hulking X8800	5.7										
McNair S338	5.9										
Farmland Co-op 2290	6.0										
Ring Around RA2601	6.0										
Hulking X980	6.2										
H55 x Mo5 <sup>2</sup> /	6.8										
Coefficient of variation . . . . . percent											15.71
Least significant difference . . . . .											1.18

<sup>1</sup>Duncan's Multiple Range Test—Entries with the same line in common are not considered significantly different at the 5% level.

<sup>2</sup>Check hybrids.



vicious years. The more vigorous hybrids showed fewer virus symptoms than any of the less vigorous, inbred lines.

In general, higher incidence of virus symptoms in field corn was reported from many areas of the state. The increase in incidence may have been associated with higher stress during July and August as the result of above-average temperatures and below-average rainfall.

### Commercial Hybrids

Virus ratings were made on 58 commercial hybrids and 6 check hybrids at the Delta Center (table 2, exp. V-8) and House Springs (table 3, exp. V-7). At the Delta Center, no significant difference was detected among 39 of the 58 tested. The high level of virus infection identified many highly susceptible hybrids; results at House Springs showed no significant difference for virus ratings among 32 of the 58 tested.

**Table 4.—1976 virus ratings for inbred lines in the open-end test sponsored by the Southern Corn Improvement Conference. Grown on the Bonacker farm near House Springs, Jefferson County, Mo.; planted May 21 and rated August 4. Experiment V-9.**

Inbred lines	Virus Ratings	DMRT <sup>1</sup>
Oh7B 75:233-234	4.4	
Tenn (75:1331)	4.5	
Mp 72:299	4.7	
Tenn 232 2	4.8	
Mo35 74:3428	5.1	
Oh4531	5.3	
Mo(Mo14W <sup>2</sup> x Oh7B)S <sub>5</sub> 75:2515	5.4	
Mo(Syn A High)S <sub>5</sub> 75:2944	5.7	
Tx5855	5.7	
Tx602	5.8	
Ark 361	5.8	
Mo(Syn A High)S <sub>4</sub> 74:1224	5.9	
Tx403	6.0	
Mo(Syn B High)S <sub>5</sub> 75:1715	6.2	
Mp 71:222	6.2	
Tenn (75:188)	6.2	
ARK 373	6.4	
Mo36 74:3453	6.5	
Tx6252-46	6.6	
ARK 359	6.8	
ARK 347	6.8	
Mo5	6.8	
H55	7.3	
ARK 342	7.3	
Coefficient of variation . . . . .		percent 9.76
Least significant difference . . . . .		0.95

<sup>1</sup>Duncan's Multiple Range Test--Entries with the same line in common are not considered significantly different at the 5% level.

**Table 5.—1976 virus ratings for inbred lines in the Southern Corn Improvement Conference Uniform Test grown at the Delta Center near Portageville, Pemiscott County, Mo.; planted May 24 and rated August 9. Experiment V-12.**

Hybrid	Virus Ratings	DMRT <sup>1</sup>
T143	6.0	
T232	6.0	
Oh7B 75:233-234	6.2	
Oh513	6.4	
Tx601	6.7	
T240	7.0	
Ga209	7.1	
SC229	7.3	
Mo17C	7.4	
Mp490	7.4	
Ky21	8.2	
Mo5 75:285	8.3	
Coefficient of variation . . . . .		percent 8.01
Least significant difference . . . . .		0.92

<sup>1</sup>Duncan's Multiple Range Test--Entries with the same line in common are not considered significantly different at the 5% level.

**Table 6.—1976 virus ratings for inbred lines in the Southern Corn Improvement Conference Uniform Test grown on Bonacker's farm near House Springs in Jefferson County, Mo.; planted May 21 and rated August 4. Experiment V-11.**

Hybrid	Virus Ratings	DMRT <sup>1</sup>
Oh7B 75:233-234	5.8	
T143	6.5	
GA209	6.5	
T232	6.6	
Oh513	6.7	
Tx601	6.9	
Mp490	7.0	
T240	7.3	
Mo17C	7.3	
SC229	7.9	
Mo5 75:285	8.2	
Ky21	8.3	
Coefficient of variation . . . . .		percent 6.67
Least significant difference . . . . .		0.77

<sup>1</sup>Duncan's Multiple Range Test--Entries with the same line in common are not considered significantly different at the 5% level.

**Table 7.—1976 virus rating for experimental hybrids grown on the Bonacker farm near House Springs, Jefferson County, Mo. Seed supplied by Illinois Foundation Seeds, Champaign, Ill. Planted May 21 and rated August 4. Experiment V-20.**

Hybrid	Virus Ratings	DMRT <sup>1</sup>
Oh513(FR2A x Oh514)	2.6	
(Mo17 x Oh514)H95	3.3	
(FR4C x Oh514)T232	3.4	
FRMo17 x H95	3.5	
Oh509A x FRMo17	3.5	
FR2A x Oh509A	3.5	
Oh514 x H95	3.7	
(Oh509A x Oh514)T232	3.7	
(T224 x T232)(CI44 x FR103)	3.8	
T224 x T232)(CI44 x FR37)	3.8	
FR4C x H95	3.9	
(T224 x T232)(FR2A x FR2B)	3.9	
N160 x FRMo17	3.9	
(FR07 x FR21E)Va35 x C103D	4.0	
FRN28 x Oh514	4.0	
(T224 x T232)(FR49 x FR37)	4.0	
GT112 x FR5	4.0	
(FR2A x Oh514)Mo7	4.0	
(FR07 x FR21E)Oh514	4.0	
(T224 x T232)(FR21E x T8)	4.1	
(FR4C x Oh514)FRMo17	4.1	
(CI44 x O7rf)Mo17 x FR103D	4.1	
(FR14A x Oh514)Mo17	4.1	
(CI44 x O7rf)Ca35 x C103D	4.1	
FR177 x Oh509A	4.2	
FRMo17 x N7Aht	4.2	
FR4A x H95	4.2	
(FR07 x FRCI21E)FR13	4.2	
(T224 x T232)Va35 x FR13	4.3	
N160 x FR4Aht	4.3	
(Mo17 x FR5) x FR14A	4.3	
Oh514 x Oh509A	4.3	
Mo7 x B68	4.4	
(FR4A x Mo17)Oh514	4.4	
Va26ht x N160	4.5	
(CI44 x O7rf)Mo17 x FR13	4.5	

Table 7.—1976 virus rating for experimental hybrids grown on the Bonacker farm near House Springs, Jefferson County, Mo. Seed supplied by Illinois Foundation Seeds, Champaign, Ill. Planted May 21 and rated August 4. Experiment V-20.—Continued

Hybrid	Virus Ratings	DMRT <sup>1</sup>
(FR4A x FR5)Va26 <sup>ht</sup>	4.5	
B73 x H95	4.5	
N142 x B73	4.5	
N159 x FRMo17	4.5	
Mo17 x Va35 x Oh514	4.5	
H95 x FR153R	4.5	
(FR15A x Oh514)FRMo17	4.5	
Va35 x Oh514	4.6	
(FR3 x FR4AOh514	4.6	
N159 x N160	4.6	
(FR13A x FR13)Oh514	4.6	
FR4C x Mo7	4.6	
Va26 <sup>ht</sup> x Oh509A	4.7	
(FR4C x Oh514) x Mo17	4.7	
FRN28 x H49	4.7	
(T224 x T232)(FRN28 x FR2A)	4.7	
(FR3 x Oh545)Oh514	4.7	
N159 x FRVa26	4.7	
FR15A x Oh514	4.8	
B73 x Mo7	4.8	
FRMo17 x Oh514	4.8	
(B73 x Oh514)FRMo17	4.8	
Mo17 x N7A <sup>ht</sup>	4.8	
N7A x FR43	4.8	
FRN28 x H95	4.8	
(Mo17 x FR5)(FR4B x FR4C)	4.9	
FR4C x Oh514	4.9	
(Mo17 x B73)FR5	4.9	
(FR37 x FR5)Mo17 x FR103D	4.9	
Va26 <sup>ht</sup> x N159	4.9	
H49 x FR4A	4.9	
(FR3 x FR37)Oh514	5.0	
(FR4A x FR5)Mo17 x FR103D	5.0	
N7A x FRVa26	5.0	
FR4A x Oh514	5.0	
(Mo17 x FR5)FR37 x H84	5.1	

Table 7.—1976 virus rating for experimental hybrids grown on the Bonacker farm near House Springs, Jefferson County, Mo. Seed supplied by Illinois Foundation Seeds, Champaign, Ill. Planted May 21 and rated August 4. Experiment V-20.—Continued

Hybrid	Virus Ratings	DMRT <sup>1</sup>									
N160 x FRVa26	5.1										
FR37 x Mo7	5.1										
(FR4A x FR5)Oh545	5.1										
FRVa26 x N142	5.1										
(FR37 x FR4C)Mo7	5.1										
(FR15A x Oh514)FR13	5.2										
Mo7 x Mo17	5.2										
FRVa26 x Oh509A	5.2										
(FR49 x FR37)(FRN28 x Mo17)	5.2										
(FR13 x Va35)Oh514	5.2										
Oh509A x FR4C	5.3										
Mo7 x FR2A	5.3										
H98 x FR5	5.3										
(Mo17 x FR5)FR4A x FR37	5.3										
N159 x B73	5.3										
(Mo17 x FR5)FR4C	5.3										
(FR3 x FR4A)FR5	5.3										
(Mo17 x FR5)FR4A x FR4C	5.5										
(FR37 x FR5)Mo17	5.5										
B73 x N7A <sup>ht</sup>	5.5										
Oh514 x B73	5.5										
FR4A x FR5	5.6										
(FR4A x FR5)Mo17 x FR13	5.6										
(FR4B x FR4C)FR5	5.7										
N159 x FR4A <sup>ht</sup>	5.8										
(FR4A x FR5)Va50	5.9										
N7A x FR14A	6.1										
(FR14A x Oh514)Oh545	6.2										
Coefficient of variation . . . . .										percent	13.92
Least significant difference . . . . .											1.29

<sup>1</sup>Duncan's Multiple Range Test—Entries with the same line in common are not considered significantly different at the 5% level.



The lack of significant differences in virus ratings between the majority of hybrids indicated increased tolerance among the new commercial hybrids.

### Uniform Test of Inbred Lines

An open-end test sponsored by the Southern Corn Improvement Conference was grown again in 1976, and 24 entries were rated for virus symptoms at House Springs (table 4, exp. V-9). Seven entries rated significantly better than the other 17. These were Oh7B, Tenn 75:1331, Mp 72:299, Tenn 232, Mo35 74:3428, Oh4531 and Mo(Mo14W<sup>2</sup> × Oh7B)S<sub>5</sub> 75:2515. Adverse weather after planting and birds destroyed the Delta Center counterpart of this test.

Twelve inbred lines in the Southern Corn Improvement Conference Uniform Test were grown and rated at the Delta Center (table 5, exp. V-12) and House Springs (table 6, exp. V-11). At the Delta Center, none of the inbreds rated lower than 6; but those rating significantly better were T143, T232, Oh7B, Oh513, Tx601, and T240. At House Springs, none of the inbreds rated less than 5.8. The four that rated significantly better were Oh7B, T143, Ga209, and T232.

### Experimental Hybrids

Seed of 100 experimental hybrids were supplied

by the Illinois Foundation Seed Association. These hybrids were planted in two replications and rated at House Springs (table 7, exp. V-20). Twenty-eight hybrids had significantly higher virus tolerance than the others. Ten of the hybrids had a range in ratings from 2.6 to 3.8. These hybrids would be considered very tolerant, especially under the conditions to which they were exposed in 1976.

### Conclusions

Virus symptoms and the level of infection were more severe in 1976 than at any time since 1972 at House Springs and since 1968 at the Delta Center. Presumably, the heat and drought that prevailed enhanced virus severity and lowered the tolerance of the corn plants. In spite of the virus severity, strains differed in their degree of tolerance. A potential virus threat exists wherever johnsongrass grows; therefore, growers should select hybrids with the highest level of virus tolerance. In the results reported here, several hybrids had levels of tolerance that should be suitable for planting in virus-problem areas.

In general, corn breeders have been quite successful in developing new hybrids with greater tolerance. During the past 6 years, the number of commercial hybrids with high levels of tolerance has increased.

## Virus Tolerance Ratings of Corn Strains Grown in Ohio<sup>1</sup>

W. R. Findley, Raymond Louie, J. K. Knoke, and E. J. Dollinger<sup>2</sup>

Corn strains (inbred lines and hybrids) grown on the Jim Daulton Farm in the Ohio River Valley near Portsmouth, Ohio, were rated for virus diseases resulting from natural infection.

The Ohio Agricultural Research and Development Center (OARDC), North Central Corn Breeding Research Committee (NCCBRC) and Southern Corn Improvement Conference (SCIC) each sponsored an inbred test. The hybrid test was conducted cooperatively with the OARDC and the Ohio Cooperative Extension Service.

Seeds of the corn strains were planted in replicated plots on May 11. Plots were 18 feet long with aisles between plots of 4 feet and rows 36 inches apart. Twenty-five seeds from inbred plants were single-space planted per one-row plot. Seeds of each hybrid were planted in two-row plots, 60 seeds per row and later thinned to 37

plants. Inbreds in the SCIC test were grown in three replications, and those in the other two tests were grown in two replications. The hybrids were grown in four replications.

Seedling emergence generally was good, resulting in satisfactory stands in nearly all plots. Weather conditions usually were favorable for corn growth, except for 2-week dry periods in early June and again in early July. During the latter period the plants showed signs of moisture stress,

<sup>1</sup>Cooperative investigations of the Agricultural Research Service, U.S. Department of Agriculture; the Ohio Agricultural Research and Development Center, Wooster; and the Ohio Cooperative Extension Service.

<sup>2</sup>Agronomist, plant pathologist, and entomologist, Agr. Res. Ser., U.S. Dept. of Agr. and professor of agronomy, Ohio Agr. Res. and Dev. Ctr., Wooster, Ohio.



**Table 8.—Incidence of maize dwarf mosaic (MDM) on inbred lines in the Ohio Agricultural Research and Development Center test on August 11.**

Inbred	MDM - %	DMRT <sup>1/</sup>
Pa405	0	
Oh513	0	
B54	0	
Tx601	7.5	
AR206	7.7	
T(CM105)	9.8	
Oh7B	13.7	
CG1	16.3	
Oh07	16.5	
Oh514	24.4	
Ky61-2335	26.3	
Mo20W	27.1	
N7B	36.4	
Mo12	38.2	
GA203	41.7	
Oh516	42.6	
GT3	43.3	
GA209	43.8	
Oh4523	43.9	
Pa884P	47.4	
N6J	50.2	
Oh4531	54.7	
A239	58.3	
Va94	58.4	
Oh509	58.9	
Oh72-588	62.5	
Mo17	63.2	
Va93	65.1	
Cl03	66.7	
Va92	70.7	
Oh509A	82.2	
Mo5	84.7	
33-16	85.0	
Akh42	88.9	
Va72	91.7	
Ky226	95.0	
E14-2-9	96.9	
Va35	100.0	
B73	100.0	
Oh517	100.0	
Coefficient of variation	33.4%	
Least significant difference	32.4	

<sup>1/</sup> Duncan's Multiple Range Test - Entries with the same line in common are not considered significantly different at the 5% level.

particularly those plants severely affected by virus infection. Weeds were controlled by herbicides and cultivation.

#### Virus Incidence

Maize dwarf mosaic (MDM) and maize chlorotic dwarf (MCD) were present in trap plants at the

test site when the plots were seeded. Incidence of MDM reached 100 percent in the trap plants by the first week in June and remained near this level throughout the season, except for the third week in July and third week in August when rain apparently reduced the vector populations. Incidence of MCD in these same trap plants was 10 to 15 percent from early June to late August. The

**Table 9.—Incidence of maize chlorotic dwarf (MCD) on inbred lines in the Ohio Agricultural Research and Development Center test on August 11.**

Inbred	MCD-%	DMRT <sup>1/</sup>
T(CM105)	30.5	
Oh7B	33.7	
C103	40.0	
Oh517	40.3	
N6J	41.8	
Va94	42.5	
Oh4531	43.0	
GA209	45.5	
33-16	51.8	
Pa884P	52.5	
AR206	53.0	
Oh72-588	56.3	
Va72	56.6	
GT3	60.0	
Oh513	60.7	
Oh509	61.6	
Mo20W	63.8	
Oh4523	67.1	
Oh514	72.4	
Mo17	75.0	
Oh07	75.7	
Mo12	76.3	
Oh509A	77.9	
Pa405	82.0	
GA203	84.1	
N7B	84.6	
B54	86.8	
A239	87.6	
Va92	87.9	
Tx601	88.3	
CG1	89.0	
Va93	91.7	
E14-2-9	93.7	
Va35	95.8	
Mo5	96.2	
Ky61-2335	97.4	
Oh516	97.4	
AKh42	100.0	
Ky226	100.0	
B73	100.0	
Coefficient of variation	20.8%	
Least significant difference	29.4	

<sup>1/</sup> Duncan's Multiple Range Test - Entries with the same line in common are not considered significantly different at the 5% level.

susceptible trap plants were potted 14-day-old WF9×Oh51A seedlings exposed for 7 days throughout the growing season.

Disease incidence appeared high and uniform over the test area. Four strips of johnsongrass, 8 feet wide and spaced 50 feet apart, extended over the length of the test area. Any one test entry was no more than 25 feet from johnsongrass,

the overwintering host of MDM and MCD viruses.

Symptoms of MDM appeared as chlorotic patterns of mosaic, ring, fleck, mottle and streak, primarily on the youngest leaves. The diagnostic symptom for MCD was chlorotic streaking in the smallest (tertiary) leaf veins. Severe infection by one virus often masked the symptoms of the other.

Table 10.—Virus ratings on inbred lines in the Ohio Agricultural Research and Development Center test on August 26.

Inbred	Virus ratings	DMRT <sup>1/</sup>
T(CM105)	3.5	
GA209	4.5	
N7B	4.5	
Oh07	4.5	
Oh7B	4.5	
N6J	4.5	
Oh514	4.5	
Oh513	4.5	
Oh4531	5.0	
Ky61-2335	5.0	
Mo12	5.0	
Pa405	5.0	
Tx601	5.0	
A239	5.0	
Oh509	5.0	
Mo20W	5.0	
B54	5.0	
Va72	5.5	
Va93	5.5	
Va94	5.5	
Oh509A	5.5	
GA203	5.5	
C103	5.5	
Oh517	5.5	
AR206	6.0	
GT3	6.0	
Pa884P	6.0	
Ky226	6.0	
33-16	6.0	
Oh516	6.0	
AKh42	6.5	
Oh4523	6.5	
Oh72-588	6.5	
CG1	7.0	
Va35	7.0	
Mo17	7.0	
E14-2-9	7.0	
Va92	8.0	
B73	8.5	
Mo5	9.0	
Coefficient of variation	13.9%	
Least significant difference	1.51	

<sup>1/</sup> Duncan's Multiple Range Test - Entries with the same line in common are not considered significantly different at the 5% level.

### Virus Rating Systems

Two systems for evaluating effects of the viruses were established. In the first system, disease incidence in the test entry was determined. Observations for symptoms of MDM and MCD were made on individual plants in the NCCBRC test on July 22 and on plants in OARDC test and SCIC open-end (no restriction on inbred entries) test on

August 11. In these tests dead plants were assumed infected with both MDM and MCD. A few dead plants were found in the hybrid test when the ratings were made on August 4.

In the second rating system, disease severity was determined. Virus severity ratings were made on August 11 in the SCIC test, August 26 in the OARDC and NCCBRC tests and August 4 in the

**Table 11.—Incidence of maize dwarf mosaic (MDM) on inbred lines in the North Central Corn Breeding Research Committee uniform test on July 22.**

Inbred	MDM-%	DMRT <sup>1/</sup>
Oh7B	7.7	
Mo75:740	9.8	
Mo75:772	11.6	
Oh74-5232	12.2	
Oh51A	18.7	
Mo75:758	37.0	
N139	41.6	
N142	43.9	
N132	51.8	
W462	54.2	
Mo75:770	54.7	
N7A	58.4	
A662	58.6	
CG11	61.2	
N152	61.7	
W729D	72.3	
CG13	73.2	
Mo75:736	73.5	
Mich.75-1	75.0	
B14	77.1	
R806	77.8	
ND486	78.9	
Mich.75-5	79.0	
N101	79.6	
W64A	81.0	
Ia.1263	81.3	
CG14	81.8	
Mo75:759	82.5	
W117	83.8	
CG15	83.8	
A661	84.1	
Mich.75-7	85.7	
Oh43	90.0	
B77	90.0	
W153R	90.7	
CG12	91.7	
Mich.75-8	91.7	
PRC517	95.1	
B75	95.3	
Ia.1259	96.9	
B76	97.0	
H55	97.1	
WF9	97.2	
ND483	100.0	
Mich.75-6	100.0	
Mich.75-9	100.0	
B37	100.0	
Coefficient of variation	18.5%	
Least significant difference	26.7	

<sup>1/</sup> Duncan's Multiple Range Test - Entries with the same line in common are not considered significantly different at the 5% level.

hybrid test. Plants were rated individually in the SCIC test and on a plot basis in the other tests. Virus ratings which included degrees of chlorosis and stunting were made on a 1 to 9 scale as follows:

- 1—Healthy.
- 2—Virus-like symptoms in top two to three leaves; symptoms faint to mild; plant not stunted.

3—Virus-like symptoms in top two to three leaves; plant not stunted.

4—Virus-like symptoms in more than three leaves; plant slightly stunted.

5—Virus-like symptoms in more than three leaves; plant moderately stunted; ear size slightly reduced.

6—Severe virus-like symptoms in more than



**Table 12.—Incidence of maize chlorotic dwarf (MCD) on inbred lines in the North Central Corn Breeding Research Committee uniform test on July 22.**

Inbred	MCD-%	DMRT <sup>1/</sup>
Oh7B	8.0	
CG13	19.6	
Oh51A	21.6	
CG15	25.7	
Oh74-5232	35.4	
Mo75:740	44.0	
N139	49.3	
Mich.75-5	55.3	
N142	56.9	
Mich.75-1	58.9	
N132	62.3	
N101	62.9	
W462	66.7	
Mo75:772	67.3	
N7A	67.5	
WF9	70.6	
Oh43	71.4	
Mich.75-7	71.4	
N152	71.7	
B77	72.5	
Mo75:770	73.8	
Mo75:759	75.0	
W64A	75.5	
B75	75.5	
CG14	76.5	
A662	76.9	
A661	77.3	
CG11	77.9	
Mo75:736	79.4	
ND486	79.5	
ND483	79.9	
Ia.1263	81.3	
B37	83.4	
W117	83.9	
W153R	86.1	
B14	86.1	
Mich.75-8	91.7	
R806	91.7	
CG12	94.5	
PRC517	95.0	
B76	97.5	
Ia.1259	100.0	
W729D	100.0	
Mich.75-6	100.0	
Mich.75-9	100.0	
H55	100.0	
Mo75:758	100.0	
Coefficient of variation	20.3%	
Least significant difference	29.6	

<sup>1/</sup> Duncan's Multiple Range Test - Entries with the same line in common are not considered significantly different at the 5% level.

three leaves; plant height reduced one-fourth to one-half; ear size moderately reduced.

7—Severe virus-like symptoms in more than three leaves; plant height reduced about one-half; poor ear shoot; many kernels.

8—Severe virus-like symptoms in more than three leaves; plant height reduced more than one-half; poor or no ear shoots; few or no kernels.

9—Dead or dying plant; no ear shoot.

Coefficient of variation (C.V.) values and least significant differences (L.S.D.) at the 5 percent level were computed for percentage MDM- and MCD-infected plants and for virus ratings. The C.V. is useful for evaluating the test uniformity; the lower the C.V. the greater the degree of test uniformity. The L.S.D. is useful in determining differences that



**Table 13.—Virus ratings on inbred lines in the North Central Corn Breeding Research Committee uniform test on August 26.**

Inbred	Virus ratings	DMRT <sup>1/</sup>
Mo75:740	4.0	
Oh74-5232	4.5	
Oh7B	4.5	
Mich.75-1	5.0	
N142	5.5	
N139	5.5	
N7A	5.5	
Mo75:772	5.5	
WF9	5.5	
N132	6.0	
N152	6.0	
Mo75:736	6.5	
B77	6.5	
B76	6.5	
Mich.75-5	6.5	
CG14	6.5	
W462	6.5	
W64A	6.5	
Oh51A	6.5	
ND483	6.5	
N101	7.0	
Mo75:770	7.0	
Mo75:758	7.0	
R806	7.0	
Mich.75-9	7.0	
CG13	7.0	
W729D	7.0	
A662	7.0	
Oh43	7.0	
ND486	7.0	
B75	7.5	
Mich.75-7	7.5	
B37	8.0	
B14	8.0	
Mich.75-8	8.0	
Mich.75-6	8.0	
CG15	8.0	
W117	8.0	
H55	8.5	
CG11	8.5	
PRC517	8.5	
Ia.1263	8.5	
Mo75:759	9.0	
CG12	9.0	
Ia.1259	9.0	
A661	9.0	
W153R	9.0	
Coefficient of variation	10.3%	
Least significant difference	1.45	

<sup>1/</sup> Duncan's Multiple Range Test - Entries with the same line in common are not considered significantly different at the 5% level.

are not due to chance 19 times in 20. Comparisons should be related to a common standard. Entries with mean differences that exceed the ranges indicated by Duncan's Multiple Range Test are significant at the 5 percent level.

#### Inbred Evaluation

Percentages of MDM- and MCD-infected plants and mean plot virus ratings of the 40 inbred lines in the OARDC test are in tables 8, 9 and 10, respectively. Many of these lines were tested in

several previous years. Inbreds T(CM105), Oh7B and Oh513 ranked best for MDM and MCD tolerance and low disease severity; however, Oh513 had 60.7 percent MCD-infected plants.

Data on inbred lines from the test sponsored by the NCCBRC are in tables 11, 12 and 13 for percentage MDM- and MCD-infected plants and mean plot virus ratings, respectively. Thirty-seven new inbred lines and the standard check lines (H55, Oh7B, B14, B37, WF9, W64A, Oh43, Oh51A, W153R and W117) were included in the test. Best inbreds for the three kinds of observations were Oh7B, Oh74:5232 and Mo75:740. The latter two lines had 35.4 percent and 44 percent MCD-infected plants, respectively.

Inbred lines in the SCIC uniform open-end test are in tables 14, 15 and 16 for percentage MDM- and MCD-infected plants and mean plot virus ratings, respectively. This test consisted of new inbred lines. Inbred 72:299 was most virus tolerant for the three kinds of observations, but more than 72 percent of the plants were MCD-infected.

## Hybrid Evaluation

Results of the hybrid test are reported in tables 17, 18 and 19 for MDM- and MCD-infected plants and mean plot virus ratings, respectively. Included were 40 (available and experimental) proprietary hybrids and 9 open-pedigree combinations. Fortunately, several hybrids with good tolerance to MDM and MCD infection are available to farmers for planting where virus diseases occur.

## Conclusion

The virus disease complex in southern Ohio is known to consist of at least several strains of MDM and MCD viruses. Incidences of the two viruses and certain strains of MDMV have been found to vary from year to year. Virus reaction differs among certain inbred lines and hybrids depending upon the virus and virus strains present. In general, inbred lines found most tolerant to the virus disease complex remain so each year but their relative tolerance varies with amount of disease exposure. High tolerance to MDM is not as rare as that to MCD among the inbred lines and hybrids tested.

**Table 14.—Incidence of maize dwarf mosaic (MDM) on inbred lines in the Southern Corn Improvement Conference uniform open-end test on August 11.**

Inbred	MDM-%	DMRT <sup>1/</sup>
Mp72:299	26.9	
Tx602	40.7	
Ark361	48.2	
Ark373	50.9	
T(75:1331)	52.4	
T232	52.5	
Mo35	58.5	
(Syn A High) <sub>S</sub> <sub>4</sub>	62.7	
Oh4531	65.6	
Ark342	69.1	
Mp71:222	72.8	
(Mo14W <sup>2</sup> xOh7B) <sub>S</sub> <sub>5</sub>	75.3	
Ark347	80.1	
Ark359	80.9	
SC229	93.5	
T(75:188)	94.4	
Tx6252-46	94.6	
(Syn A High) <sub>S</sub> <sub>5</sub>	95.9	
Tx5855	96.3	
Mo36	96.6	
(Syn B High) <sub>S</sub> <sub>5</sub>	97.0	
Tx403	100.0	
Coefficient of variation	15.7%	
Least significant difference	18.9	

<sup>1/</sup> Duncan's Multiple Range Test - Entries with the same line in common are not considered significantly different at the 5% level.

**Table 15.—Incidence of maize chlorotic dwarf (MCD) on inbred lines in the Southern Corn Improvement Conference uniform open-end test on August 11.**

Inbred	MCD-%	DMRT <sup>1/</sup>
(Mo14W <sup>2</sup> xOh7B)S <sub>5</sub>	46.4	
T232	75.2	
T(75:1331)	79.4	
Mp72:299	79.9	
Ark361	80.1	
T(75:188)	80.1	
(Syn A High)S <sub>4</sub>	81.3	
Ark342	84.4	
Ark373	84.5	
Tx403	85.9	
SC229	86.5	
Oh4531	87.3	
(Syn B High)S <sub>5</sub>	88.4	
Mo35	89.0	
Tx5855	91.9	
Ark359	94.1	
Tx602	96.1	
(Syn A High)S <sub>5</sub>	97.9	
Ark347	100.0	
Mp71:222	100.0	
Mo36	100.0	
Tx6252-46	100.0	
Coefficient of variation	12.5%	
Least significant difference	17.9	

<sup>1/</sup> Duncan's Multiple Range Test - Entries with the same line in common are not considered significantly different at the 5% level.

**Table 16.—Virus ratings on inbred lines in the Southern Corn Improvement Conference uniform open-end test on August 11.**

Inbred	Virus ratings	DMRT <sup>1/</sup>
Mp72:299	3.0	
T(75:1331)	3.6	
(Mo14W <sup>2</sup> xOh7B)S <sub>5</sub>	3.8	
T232	3.8	
Ark361	4.5	
Ark373	4.7	
Tx602	4.7	
Mo35	5.3	
(Syn A High)S <sub>4</sub>	5.4	
Oh4531	5.5	
Mp71:222	5.6	
Tx403	5.8	
Ark342	6.1	
T(75:188)	6.4	
Tx5855	6.8	
Ark359	6.9	
SC229	7.2	
(Syn B High)S <sub>5</sub>	7.6	
(Syn A High)S <sub>5</sub>	7.7	
Ark347	7.9	
Tx6252-46	8.3	
Mo36	8.5	
Coefficient of variation	12.0%	
Least significant difference	1.2	

<sup>1/</sup> Duncan's Multiple Range Test - Entries with the same line in common are not considered significantly different at the 5% level.

**Table 17.—Incidence of maize dwarf mosaic (MDM) on commercial and open-pedigree hybrids on August 4.**

Hybrids	MDM-%	DMRT <sup>1/</sup>
Funk's G-4776	2.5	
Ruff's R-434	4.6	
Funk's Exp.27794W	5.0	
Northrup King PX79	6.2	
Voris V2671	6.4	
Madison Exp.00T	6.6	
Funk's Exp.27793	7.7	
Kenworthy KL-X74	8.2	
Northrup King PX95	8.5	
Oh514xMol7	11.3	
Funk's G-4525	11.9	
P-A-G SX17A	12.7	
Pioneer 3145	13.4	
Zimmerman Z-11W	14.6	
Pioneer 3147	15.1	
Funk's Exp.26630	15.8	
Kenworthy KL-X73	15.8	
(Oh7BxMol2) (Va.35xCI.38B)	15.9	
P-A-G Exp.246006	20.6	
Northrup King PX718W	21.4	
Madison Exp.VMO	22.2	
Funk's Exp.28170	23.0	
Funk's G-4747W	23.5	
Pioneer 3364	23.7	
Northrup King PX723	24.5	
Zimmerman Z-52W	25.3	
Funk's G-4880W	25.7	
Kenworthy KL-708L	25.8	
P-A-G Exp.236041	28.3	
Hulting X990	29.5	
Oh509AxOh74-5232	30.2	
Pioneer 3179	32.7	
Ruff's Exp.RE444	33.2	
Trojan MDM116	34.0	
DeKalb XL-72b	34.8	
Funk's G-4848	36.0	
Voris V2632	38.1	
(Oh509AxOh514)xH95	38.5	
DeKalb XL-394	40.7	
Northrup King PX715	40.8	
Oh514xOh517	43.0	
Voris V2601	47.4	
Northrup King PX91	51.6	
B79xOh509A	55.7	
Oh509AxMol7	62.3	
Oh509AxOh517	68.8	
Voris V2502	71.6	
Hulting Exp.74174	81.3	
WF9xOh51A	98.1	
Coefficient of variation	39.0%	
Least significant difference	15.6	

<sup>1/</sup> Duncan's Multiple Range Test - Entries with the same line in common are not considered significantly different at the 5% level.



**Table 18. Incidence of maize chlorotic dwarf (MCD) on commercial and open-pedigree hybrids on August 4.**

Hybrid	MCD-%	DMRT <sup>1/</sup>
(Oh509AxOh514)xH95	18.0	
Funk's Exp.26630	19.4	
Kenworthy KL-X73	19.4	
Pioneer 3147	21.2	
DeKalb XL-72b	23.2	
Voris V2502	23.8	
Ruff's R-434	24.0	
Funk's G-4525	24.6	
Oh514xMol7	28.4	
Funk's G-4776	31.1	
P-A-G Exp.236041	32.5	
Funk's Exp.27793	33.1	
DeKalb XL-394	36.0	
Northrup King PX79	37.2	
B79xOh509A	38.2	
P-A-G SX17A	39.2	
Voris V2601	40.9	
Northrup King PX718W	41.0	
Kenworthy KL-708L	41.8	
Trojan MDM116	42.1	
Funk's Exp.28170	42.7	
Funk's G-4848	43.0	
Funk's G-4880W	43.5	
Funk's Exp.27794W	44.1	
Oh509AxOh517	44.3	
Zimmerman Z-52W	45.4	
(Oh7BxMol2) (Va35xCI.38B)	45.5	
Oh509AxMol7	45.5	
Madison Exp.00T	45.5	
Madison Exp.VM0	46.8	
Oh509AxOh74-5232	47.2	
Pioneer 3145	48.7	
Zimmerman Z-11W	49.6	
Oh514xOh517	49.7	
Pioneer 3364	49.8	
Funk's G-4747W	50.0	
Voris V2671	50.3	
Kenworthy KL-X74	51.0	
Northrup King PX723	53.3	
Hulting X990	54.2	
Northrup King PX91	56.3	
P-A-G Exp.246006	57.8	
Northrup King PX95	58.0	
Pioneer 3179	59.5	
Hulting Exp.74174	61.1	
WF9xOh51A	64.1	
Ruff's Exp.RE444	65.4	
Voris V2632	67.1	
Northrup King PX715	68.1	
Coefficient of variation	27.1%	
Least significant difference	16.4	

<sup>1/</sup> Duncan's Multiple Range Test - Entries with the same line in common are not considered significantly different at the 5% level.



Table 19.—Virus ratings on commercial and open-pedigree hybrids on August 4.

Hybrid	Virus rating	DMRT <sup>1/</sup>
Oh514xMo17	3.0	
Funk's Exp.26630	3.3	
Funk's Exp.27794W	3.3	
Funk's G-4776	3.3	
Ruff's R-434	3.3	
Pioneer 3147	3.5	
Zimmerman Z-52W	3.8	
Northrup King PX79	3.8	
Northrup King PX718W	3.8	
Funk's G-4525	3.8	
Zimmerman Z-11W	4.0	
Funk's Exp27793	4.0	
Funk's G-4747W	4.0	
Funk's G-4848	4.0	
DeKalb XL-72b	4.0	
(Oh509AxOh514)xH95	4.0	
Funk's Exp.28170	4.3	
Pioneer 3145	4.3	
Voris V2671	4.3	
P-A-G Exp.236041	4.3	
DeKalb XL-394	4.5	
Kenworthy KL-X73	4.5	
Madison Exp. 00T	4.5	
Pioneer 3364	4.8	
P-A-G SX17A	4.8	
P-A-G Exp.246006	4.8	
Trojan MDM116	4.8	
Kenworthy KL-708L	4.8	
Northrup King PX723	5.0	
Funk's G-4880W	5.0	
(Oh7BxMo12)(Va35xCI.38B)	5.0	
Voris V2502	5.0	
Northrup King PX95	5.3	
Pioneer 3179	5.3	
Kenworthy KL-X74	5.3	
Madison Exp. VMO	5.3	
Voris V2632	5.5	
Oh509AxOh74-5232	5.5	
Oh509AxMo17	5.5	
Northrup King PX91	5.8	
B79xOh509A	5.8	
Hulting X990	6.0	
Northrup King PX715	6.0	
Voris V2601	6.0	
Oh514xOh517	6.0	
Hulting Exp.74174	6.5	
Ruff's Exp.RE444	6.5	
Oh509AxOh517	7.0	
WF9xOh51A	8.0	

Coefficient of variation 15.5%

Least significant difference 1.0

<sup>1/</sup> Duncan's Multiple Range Test - Entries with the same line in common are not considered significantly different at the 5% level.



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